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PATENT
24GA05998-7
(HDP Ref: 8564-000045/US/DVA)

IN THE U.S. PATENT AND TRADEMARK OFFICE

Applicant:	William E. RUSSELL et al.	Conf.:	8107
Appl. No.:	10/608,086	Group:	3641
Filed:	June 30, 2003	Examiner:	R. Palabrica
For:	SYSTEM AND METHOD FOR CONTINUOUS OPTIMIZATION OF CONTROL VARIABLES DURING OPERATION OF A NUCLEAR REACTOR		

RESPONSE TO NOTIFICATION OF NON-COMPLIANT APPEAL BRIEF

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October 18, 2005

Sir:

In response to the Notification of Non-Compliant Appeal Brief dated September 30, 2005, Applicants submit herewith a replacement Appeal Brief, with the Examiner's requested corrections made.

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If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 08-0750 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,

By: ______________________

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PATENT APPLICATION

IN THE U.S. PATENT AND TRADEMARK OFFICE

Appellants: William E. RUSSELL, II, et al.

Application No.: 10/608,086

Art Unit: 3641

Filed: June 30, 2003

Examiner: Ricardo Palabrica

For: SYSTEM AND METHOD FOR CONTINUOUS OPTIMIZATION OF CONTROL VARIABLES DURING OPERATION OF A NUCLEAR REACTOR

Attorney Docket No.: 24GA05998-7
(HDP Ref: 8564-000045/US/DVA)

APPELLANTS' BRIEF ON APPEAL UNDER 37 C.F.R. §41.37

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401 Dulany Street
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Mail Stop Appeal Brief - Patents

October 18, 2005

Sir:

In accordance with the provisions of 37 C.F.R. §41.37, Appellants submit the following:

I. REAL PARTY IN INTEREST:

The real party in interest in this appeal is General Electric Company. Assignment of the application was submitted to the U.S. Patent and Trademark Office and recorded on at Reel 012421, Frames 0963-0966.

II. RELATED APPEALS AND INTERFERENCES:

There are no known appeals or interferences that will affect, be directly affected by, or have a bearing on the Board's decision in this Appeal.

III. STATUS OF CLAIMS:

Claims 31-41 are pending in the application, with claim 31 being written in independent form.

Claims 31-39 remain finally rejected under 35 U.S.C. § 102b as being anticipated by Takeuchi.

Claims 31-39 remain finally rejected under 35 U.S.C. § 102b as being anticipated by Musick.

Claims 40-41 remain finally rejected under 35 U.S.C. § 102b as being anticipated by Takeuchi.

Claims 40-41 remain finally rejected under 35 U.S.C. § 103 as being unpatentable over Musick in view of Takeuchi.

Claims 31-41 are being appealed.

IV. STATUS OF AMENDMENTS:

Appellants have assumed for the purposes of this appeal that the After Final Amendment filed February 10, 2005 has been entered. While the

Advisory Action dated March 4, 2005 does not indicate whether this Amendment has been entered or not, on page 2 of the Advisory Action, the Examiner indicates that all Section 112 based rejections are withdrawn in view of the arguments and amendment to claim 31 made in the February 10, 2005 After Final Amendment. In view of this, and because entry of this After Final Amendment clearly reduces the issues for appeal, Appellants have assumed that the After Final Amendment dated February 10, 2005 has been entered.

V. SUMMARY OF CLAIMED SUBJECT MATTER:

FIGURE 1A shows an example hardware arrangement of components for providing a reactor control-variable optimization system. In this example, one or more host processors 10 are coupled via a local area network(LAN) 11, a wide area network (WAN) 17 or the Internet (TCP/IP network). Each processor 10 may host reactor simulation software and/or client software for accessing and displaying information provided via a graphic user interface (GUI) on a display device (12) coupled to the processor. The optimization system components may include one or more database storage devices 14 accessed via, for example, one or more database servers 13. In addition, the optimization system may include remotely located host processors and/or database storage devices in

communication with local LAN 11 via connection to a remote LAN/WAN 17 or over the Internet, for example, via TCP/IP servers 15 and 16.[1]

Referring now to FIGURE 1B, a data processing flow diagram illustrates an example system for continuous optimization of multiple operational control-variables of a nuclear reactor in accordance with the present invention. The flowchart shown provides a general processing overview of an example system and illustrates two fundamental operational processing modes: a manual input constraint definition process (manual loop 10) and an automated optimization updating process (automated loop 100). By way of the manual process, updated results from a general database 101 may be viewed (102) by using a conventional display device (12) driven by, for example, a graphical user interface (GUI). Figure 2 illustrates example content of the general database, for an example general database 201. Should a user (e.g., a design engineer) desire to modify or test an alternative operating strategy 103, such modifications may also be initiated and input (104) through the (GUI) 104. FIGURE 3 illustrates example strategy change issues.[2]

Alternatively, in the automated loop, processing takes place as shown in FIGURE 4. As shown, new updated state-point (described in detail below) is determined and, using data from the general database 401 (database 101 in FIGURE 1B), a comparison 402 is performed to determine

[1] See page 10, paragraph 30 of the specification.
[2] See page 11, paragraph 32 of the specification.

if the most recent updated state-point is different than the state-point obtained from a previously run simulation. If the latest state-point has not changed (403), state-point comparisons 402 are continued. If the state-point has changed (404), a copy of the new state-point is copied to Optimization Inputs Database 409 (database 106 in FIGURE 1B). The "receiving state-point data" step of claim 31 reads on at least this portion of the specification. In addition, a small change is made to the operational strategy (405) to reflect the change in the starting exposure. With the strategy starting point updated and the small modification made to reflect the new starting point time, an optimization request flag is set (406) to identify the system for an optimization request.[3]

Once selected optimization inputs have been modified, the various inputs are stored, for example, within optimization inputs database 106, which may be distinct from, or form a portion of, general database 101. FIGURE 5 illustrates example optimization inputs. Next, using the appropriate inputs stored in optimization inputs database 106, an optimization program 107 determines appropriate values for the independent control-variables and provides resulting values for all dependent variables. The "performing an optimization process" step recited in claim 31 reads on at least this step. This optimization output 108 is stored to general database 101 for subsequent access and viewing.

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[3] See page 15, paragraph 54 of the specification.

Optimized values for operational control variables (e.g., rod pattern, flow strategy, sequence exchange times, sequence lengths, etc.) are provided as displayable outputs for use in the operational management of the nuclear reactor core. [4]

As previously mentioned, one aspect of the present invention provides automatic updates to control-variables and automatically updates the status of a currently operating reactor based on a predefined preferred operating strategy. To implement this automated aspect of the invention, an updated nuclear reactor state-point is first obtained from a general database 101 (loop 100). The updated state-point data may be produced, for example, from actual monitoring devices and sensors on the reactor or as a result of simulating reactor operations by a conventional reactor simulator process or program provided on one or more host processors 10 connected via networks 11, 17 or 18 of FIGURE 1A. The updated reactor state-point information is then used to make modifications to various optimization input parameters stored in Optimization Inputs database 106 based on an operational strategy set up during the manual input loop process(10).[5] The "receiving state-point data" step of claim 31 also reads on at least this portion of the disclosure.

An example optimization methodology according to an embodiment of the present invention is illustrated in FIGURE 6B. As indicated at block

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[4] See page 11-12, paragraph 33 of the specification.
[5] See page 12, paragraph 34 of the specification.

612, the most recent simulation state-point (501) information and user-specified optimization constraints (505) are obtained from Optimization Inputs database 611. Next, at block 613, the processing of two reactor simulator cases is initiated for each independent variable in order to determine the functional relationship of dependent variables to a change in a specified independent variable. The "first simulating" step of claim 40 reads on at least this portion of the disclosure. Next, at block 614, the generation of a polynomial response surface is determined by solving for the coefficients of the polynomial. (The response surface transfer functions being normalized about the center-point to prolong usefulness during the optimization phase). Since there may be as many as several hundred independent variables, and a couple hundred thousand dependent variables for each independent variable, the above processing may potentially result in producing millions of polynomial response surface transfer functions. [6]

Namely, each simulation is representative of a different virtual operational case and comprises different sets of values for various reactor core operational parameters (i.e., the independent control-variables). The reactor core simulations provide output data that is indicative of selected performance parameters, which reflect the operational state of the reactor throughout the duration of a reactor core fuel cycle. Once all reactor core

[6] See page 16, paragraph 57 of the specification.

simulations are completed, the simulation output data for each control-variable case is accumulated, normalized and mapped by a host processor to corresponding high-order polynomials that fit the reactor core simulation results data for each control-variable case. Coefficients that uniquely describe each polynomial are collected in an associated memory device as a multidimensional data array that serves as a type of virtual "response surface".[7] The "generating transfer functions" step of claim 40 reads on at least these portions of the disclosure.

Once the transfer function polynomial response surface is generated, it can be used to "predict" the response of the dependant variables for a given change in value of an independent variable 615. Consequently, computing simulated value changes for each of the independent variables provides an estimate of an optimum modification (i.e., change in quantitative value) which may be made to each independent variable. When such predictions indicate that an improvement exists relative to a previous iteration, the scenario is simulated using a reactor operation simulator which may, for example, be a simulation program or process performed by one or more other host processors coupled to the network. A looping 619 of computing polynomial response surface predictions 615 and performing simulator calibrations/corrections is repeated until either: 1) the response surface becomes inaccurate, 2) a predetermined number of

[7] See page 8, paragraph 24 of the specification.

iterations is reached, or 3) until no further significant improvements to the computed solution are realized. Once loop 619 is exited, the range of the independent variable selection is reduced (616) and a new response surface is regenerated 620. This larger response surface computation loop (620) is pursued until changes to an independent variable no longer improve the computed solution by a predetermined margin which may be specified by the user-input constraints. Once the optimization is complete, computed optimization output values 617 are stored in an optimization database 618.[8] The "determining" step of claim 40 reads on at least these portions of the disclosure.

In this manner, the virtual response surface acts as a cyber-workspace and repository for storing resultant output data from many control-variable case simulations. The polynomials are used to predict quantitative values (i.e., dependent variables) for the reactor performance parameters over a limited range of independent control-variable values. The predicted performance parameter values from each polynomial predictor are compared using an objective function to determine which particular associated independent control-variable(s) is likely to produce the greatest improvement.[9]

FIGURE 7 is a block diagram illustrating example contents of information stored in an Optimization Output database 702, provided on a

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[8] See pages 16-17, paragraph 58 of the specification.
[9] See pages 8-9, paragraph 25 of the specification.

storage device in the system network. Three primary categories of optimization database contents are illustrated which include: 1) optimization status data 704, 2) optimization independent control-variables 705, and 3) resulting optimization dependent variable output predictions 706. The Optimization Status data, 704 may include, but is not limited to, comparison results to design values, cycle length improvement, optimization results, optimization path, optimization status, and strategy comparisons. The Optimization independent Control-Variables, 705 may include, for example, the location of the preferable control blades and equivalent blade groupings at all future requested exposures, the preferable core average flow at all future requested exposures, and the preferable sequence exchange exposure intervals. The Optimization Dependent variable output predictions, 706, may include (but are not limited to), for example, LHGR results, CPR results, cycle exposure, bundle exposure, core average exposure, blade depletions, core inlet enthalpy, LPRM data, hot reactivity bias, cold reactivity bias, thermal power, and electric power. [10]

VI. GROUNDS OF REJECTION TO BE REVIEW ON APPEAL:

Appellants seek the Board's review of (1) the rejection of claims 31-39 under 35 U.S.C. § 102b as being anticipated by Takeuchi; (2) the rejection

[10] See page 17-18, paragraph 59 of the specification.

of claims 31-39 under 35 U.S.C. § 102b as being anticipated by Musick; (3) the rejection of claims 40-41 under 35 U.S.C. § 102b as being anticipated by Takeuchi; and (4) the rejection claims 40-41 under 35 U.S.C. § 103 as being unpatentable over Musick in view of Takeuchi.

VII. ARGUMENTS:

A. Appellants traverse the rejection of claims 31-39 under 35 U.S.C. § 102b as being anticipated by Takeuchi.

Claims 31-39 rise and fall together.

i) Claim 31

In Takeuchi, current reactor data may be fed to an expert system 20 such as shown in Figure 1. The expert system 20 operates according to a process shown in Figure 2. Figure 2 is a flow chart showing that the expert system determines if the reactor is operating in an abnormal condition in step 41. If so, the expert system 20 determines if there is evidence of a reactor scram in step 42.[11] Reactor scram is an emergency shut down of the reactor. While Takeuchi is not limited to detecting reactor scram, Takeuchi is exclusively concerned with operation effecting events such as

[11] See col. 4, lines 35-58.

reactor scram.[12] Based on the determination in step 42, diagnostics are performed (see steps 44 and 46).[13] Subsequently, future effects are predicted in step 50.[14]

Accordingly, Takeuchi uses current plant operating data to determine if an abnormal condition has occurred, and performs diagnostic operations to determine the most likely cause of the abnormal condition. Takeuchi also predicts the future effects of the abnormal condition diagnosed.

However, Takeuchi makes no mention nor teaches "performing an optimization process on one of a computer and computer network based on the received state-point data" and that the optimization process generates "one or more independent control variable values" as recited in claim 31.

The Examiner states on page 2 of the March 4, 2005 Advisory Action:

> The term, "optimization" is defined in the dictionary as "[a]n act, process or methodology of making something (as a design, system or decision) as fully perfect, functional or effective as possible." (see Merriam Webster's Collegiate Dictionary, 10th edition, 1993).
>
> ⋮
>
> Takeuchi's invention provides the operator with an expert's analysis of current operating data, determine the probabilities of existence of abnormal circumstances and predict the likelihood of future events based on said current data (see col. 1, line 36+). Thus, Takeuchi's expert system provides an optimization that meets the ordinary definition of "optimization" because it allows the operator to maintain the plant within operating limits, prevent occurrence of scrams, and thereby make the operations fully functional or effective.

[12] See col. 4 lines 41-48.
[13] See Fig. 2, and col. 5, lines 4-15 and lines 38-44.
[14] See col. 5, lines 52-56.

Even assuming, the Examiner's definition of optimization is correct, the Examiner has still failed to prima facie show that Takeuchi teaches the claimed "performing optimization" step. As the above-quoted portion of the March 4, 2005 Advisory Action evidences, even the Examiner recognizes that Takeuchi's expert system does not determine "one or more independent control variable values". Instead, the expert system provides recognition of a problem event, and, as state by the Examiner, this may allow the operator to maintain the plant within operating limits, prevent occurrence of scrams, and thereby make the operations fully functional or effective.

Claim 31 requires that the optimization process performed "on one of a computer and computer network ... generate one or more independent control variable values;" not an operator. Furthermore, appellants disagree with the Examiner's characterization of the supplied definition for the word "optimization". Appellants would hardly characterize an operator scramming a nuclear reactor or making adjustments to avoid a dangerous operating situation as "making something (as a design, system or decision) as fully perfect, functional or effective as possible." Accordingly, appellants submit that Takeuchi does not disclose or suggest performing an optimization process, let alone "performing an optimization process on one of a computer and computer network based on the received state-point data

to generate one or more independent control variable values," as recited in claim 31.

ii) Claims 32-39

Claims 32-39, dependent on claims 31, are patentable at least for the reasons stated above with respect to claim 31.

B. Appellants traverse the rejection of claims 31-39 under 35 U.S.C. § 102b as being anticipated by Musick.

Claims 31-39 rise and fall together.

i) Claim 31

Musick is directed to a protection system for a nuclear reactor. No elements, process, etc. within Musick performs an optimization process.

On page 9 of the Office Action dated March 11, 2004, the Examiner asserted:

> Applicant's claim language reads on Musick's method as follows: a) "optimization process" reads on the core protection calculator (e.g., see Figs. 6 and 6A).

The core protection calculator referred to by the Examiner determines if the reactor exceeds some constraint requiring a control action such as scramming the reactor.[15] Reactor scram involves stopping the nuclear reaction; namely, shutting down the nuclear power plant.

On page 7 of the November 10, 2004 Final Office Action, the Examiner, in rebutting Appellant position, stated:

> Musick teaches a combination of a Core Protection Calculator and Core Operating Limit Supervisory System to protect the nuclear reactor from design limit violations both in steady state operation and during transients (see col. 23, lines 5+). Thus, Musick's system performs some optimization to ensure that the operations stay within design limits.

Musick discloses in col. 23, lines 40 – 47 that the Core Operating Limit Supervisory System (COLSS) calculates a reactor core operating limit, and that this limit provides a sufficient margin to the design limits to allow the Core Protection Calculator to respond to an incident and terminate the reactor core chain reaction before the design limits are violated.

Appellants would hardly characterize scramming a nuclear reactor to avoid a dangerous operating situation as "making something (as a design, system or decision) as fully perfect, functional or effective as possible."[16] Accordingly, appellants submit that Musick does not disclose or suggest performing an optimization process, let alone "performing an optimization

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[15] See col. 11, line 40 – col. 12, line 4, and col. 12, lines 30 – 45.
[16] It will be recalled that this is the Examiner's asserted definition for the term "optimization".

process on one of a computer and computer network based on the received state-point data to generate one or more independent control variable values," as recited in claim 31.

ii) Claims 32-39

Claims 32-39, dependent on claim 31, are patentable at least for the reasons stated above with respect to claim 31.

C. Appellants traverse the rejection of claims 40-41 under 35 U.S.C. § 102b as being anticipated by a paper by Takeuchi.

Claims 40 and 41 rise and fall together.

i) Claim 40

As demonstrated above, Takeuchi does not disclosure or suggest an optimization process, and therefore, can not disclosure or suggest the optimization process recited in claim 40.

The Examiner's detailed position of why Takeuchi anticipates claim 40 is given on page 9 of the March 11, 2004 Office Action, and consists only of the statement:

As to the limitations in the claims regarding "simulating reactor operation", Takeuchi et al. disclose the use of simulated plant data in place of actual plant data (see column 1, lines 62+).

Besides the recitation of "simulating reactor operation", claim 40 further recites:

> generating transfer functions based on the sets of independent control variable values and the sets of dependent performance variable values, the transfer functions representing functional relationships between the independent control variables and the dependent performance variables; and
>
> determining a set of independent control variable values for possible use in operating the operating nuclear reactor using the transfer functions.

Neither of these limitations are disclosed or suggested by Takeuchi, nor has the Examiner provided any basis with respect to Takeuchi that such limitations are taught. According, the Examiner has not established a prima facie case of anticipation or obviousness with respect to claim 40 based on Takeuchi.

ii) Claim 41

Claim 41, dependent on claim 40, is patentable at least for the reasons stated above with respect to claim 40.

D. Appellants traverse the rejection of claims 40-41 under 35 U.S.C. § 103 as being anticipated by Musick in view of Takeuchi.

Claims 40 and 41 rise and fall together.

i) Claim 40

As demonstrated above, Musick and Takeuchi do not disclose or suggest an optimization process, and therefore, when combined can not disclosure or suggest the optimization process recited in claim 40.

Furthermore, in rejecting claim 40 on this art grounds, the Examiner relies on Takeuchi as teaching the claimed optimization process, and asserts it would have been obvious to have combined Takeuchi with Musick. As discussed above, Takeuchi does not disclose many of the limitations in claim 40. Therefore, even assuming that one skilled in the art would have combined Takeuchi with Musick, the resulting combination does not provide for the optimization process recited in claim 40.

Also, the reason given by the Examiner as to why one skilled in the art would combine the teachings of Takeuchi with Musick is not understood by Appellants. Musick is a protection system to prevent a reactor from achieving a dangerous operating condition. If Takeuchi was combined with Musick so that simulated (rather than actual) data was used

by Musick as suggested by the Examiner,[17] this would defeat the intended purpose of Musick.

Accordingly, Musick in view of Takeuchi would not have rendered claim 40 obvious to one skilled in the art.

ii) Claim 41

Claim 41, dependent on claim 40, is patentable at least for the reasons stated above with respect to claim 40.

VIII. APPENDICES:

As there are no related appeals and interferences, copies of decisions rendered by a court or the Board for such proceedings do NOT exist and have not been supplied in an Appendix pursuant to 41.37(c)(1)(x).

As no evidence was submitted and relied upon in this Appeal, an Appendix pursuant to 41.37(c)(1)(ix) has not been supplied.

XI. CONCLUSION:

Appellants respectfully request the Board to reverse the Examiner's anticipation and/or obviousness rejections of claims 31-41.

[17] See page 10 of the March 11, 2004 Office Action

Pursuant to 37 C.F.R. 1.17 and 1.136(a), the Appellants respectfully petition for a two month extension of time for filing a response in connection with the present application, and the required fee of $450.00 is attached.

The Commissoner is authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 08-0750 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,
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CLAIMS APPENDIX

Claims 31-41 on Appeal:

Claim 31. A method of determining independent control variable values for a nuclear reactor under operation, comprising:

receiving state-point data for the operating nuclear reactor, the state-point data including current values for independent control variables and for dependent performance variables of the operating nuclear reactor; and

performing an optimization process on one of a computer and computer network based on the received state-point data to generate one or more independent control variable values.

Claim 32. The method of claim 31, further comprising:

receiving a change in at least one constraint of the nuclear reactor operation; and wherein

the performing step performs the optimization process on one of a computer and computer network based on the received state-point data and the at least one changed constraint.

Claim 33. The method of claim 32, further comprising:

executing the performing step in response to receiving state-point data that differs from previously received state-point data.

Claim 34. The method of claim 31, further comprising:

executing the performing step in response to receiving state-point data that differs from previously received state-point data.

Claim 35. The method of claim 31, further comprising:

repeating the receiving and performing steps throughout operation of the operating nuclear reactor.

Claim 36. The method of claim 35, further comprising:

executing the performing step in response to receiving state-point data that differs from previously received state-point data.

Claim 37. The method of claim 31, further comprising:

displaying at least a portion of the state-point data.

Claim 38. The method of claim 37, further comprising:

displaying at least a portion of results from the performing step.

Claim 39. The method of claim 31, further comprising:

displaying at least a portion of results from the performing step.

Claim 40. The method of claim 31, wherein the optimization process comprises:

first simulating nuclear reactor operation for sets of independent control variable values to produce associated sets of dependent performance variable values;

generating transfer functions based on the sets of independent control variable values and the sets of dependent performance variable values, the transfer functions representing functional relationships between the independent control variables and the dependent performance variables; and

determining a set of independent control variable values for possible use in operating the operating nuclear reactor using the transfer functions.

Claim 41. The method of claim 40, wherein the first simulating step comprises:

treating the independent control variable values and the dependent performance variable values in the state-point data as a base set of independent control variable values and a base set of dependent performance variable values, respectively;

generating, from the base set of independent control variable values, modified sets of independent control variable values associated with each

independent control variable in a selected group of independent control variables; and

simulating nuclear reactor operation for each of the modified sets of independent control variable values to produce modified sets of dependent performance variable values.